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Several Thoughts on Conduct of Critical Process Quality Surveillance

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Abstract

Based on the three aspects to which the Aviation Industry Corporation of China need to pay close attention to the conduct of the critical process quality surveillance, the article defines the critical aspects and specific requirements for conduct of the critical process quality surveillance from the explanation on Five Performances Review, Characteristics Analysis, Technological Review, Readiness Review for the Preproduction and First Article Qualification during the product development period, the application of Statistical Process Control, Dynamic Management of critical process, Engineering Change, Material Substitution and Concession Application during production.

Key Words: Critical Process;Quality Surveillance;

Critical process is the decisive process for the successful implementation of the product quality, as well as the critical point of the quality surveillance during production. The requirements for the conduct of critical process quality surveillance are specified in article 7.3.1 i, 7.3.3 e and 7.5.6 of GJB 9001B-2009 Quality management systems requirements. Based on the practical conduct of the quality management system of AVIC (Aviation Industry Corporation of China), the point for the critical process quality surveillance is to identify the critical process and to assure the consistency and integrality of the characteristic content and mark in designing and technological document during product development

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period. The closed loop control will be carried out on the aspects of men, machines, materials, methods, environment and measurement during production.

1. Three Aspects to the Critical Process Quality Surveillance

It is necessary for an enterprise to pay close attention to the following three aspects in accordance with the authors' knowledge on Five Performances Review, Technological Review and Quality Review during development period, and Enterprise Quality Management System Auditing.

1.1. The preciseness of the characteristic analysis

GJB 190-86 Classification of characteristics states specifically that "The purpose of the characteristic classification is to help the manufacturing department understand the designing purpose for the easy distinguishing of the primary and secondary points in the implementation of quality control". The results of the production process quality control are directly affected by the preciseness of the characteristic analysis. During the review of the characteristic analysis report, we found that the content is not complete and is at will, and the analyzing results haven't been adequately demonstrated and examined, which will directly affect the preciseness of the critical process identification. After study and analysis, the reasons are as following: the designing system of the enterprise doesn't pay enough attention to the characteristic analysis; the designers haven't got the consistent understanding of the characteristic analysis; the designers don't have a complete knowledge related to the products; the designers don't have a total certainty about the technological capability level of the enterprise.

1.2. The preciseness of the transmission of the characteristic analysis content

The characteristic analysis content is transmitted to technological system through Critical Part and Major Part Items List (GJB 909A-2005 Quality control for critical part and major part). Because of the misunderstanding to the Critical Part and Major Part Items List, the employees think that the critical characteristic and major characteristic have to be corresponding to the critical part and major part, which induces the critical process established in the Technological Requirements GJB 190-86, 5.2.b can't be passed to the technological system. For example, when the designer thinks that the welding of a component directly affecting the function of a product and the major characteristic is the joint testing data after the welding of the component, he/she defines the component as the major part. Thus, in practical operation, the component will be controlled as an important purchased component.

1.3. The weak aspects in the critical process control

Although the critical and major purchased equipment and materials are identified in the Material Consumption Ration, the content of the critical and major characteristics are not defined completely. The purchasing document lacks the product technical requirements and the detailed information about the critical and major characteristics. The retesting specification and reselection specification of the incoming material haven't been generally marked, and it is easily out of control for the critical and major purchased equipment and materials during purchasing and incoming inspection.

The above problems result in the inadequacy of the identification of the critical process control, the imprecision of the transmission, and partly out of control. Besides, it also induces all controlling measures adopted lacking pertinence during manufacturing, which will affect the results of the control on the critical process and will put the function of the final product and its safety application into danger.

2. Aspects of Critical Process Control during Product Development Period

The standardization procedure of product development is perfected step by step. This has set enough controlling points for the identification and control of critical process. The controlling items, achieving methods and inspection standards have been specified through a series of National Military Standard, rules and regulations, and product type top level documents. The present controlling points should be adequately utilized during the conduct of critical process quality surveillance in product development period which should be reviewed and examined in accordance with the related requirements to make sure that the identification, mark and control of the critical process will be supervised all around.

2.1. Five Performances Review is the base of the critical process identification

FMECA (Failure mode, effects and criticality analysis) report is the focus of Five Performances Review. It specifically defines in GJB/Z 1391-2006 Guide to failure mode, effects and criticality analysis that the report broadly analyzes all possible failure modes, causes and possible effects for the product, discovers various defects and weak aspects which may affect the product function and safety application. Then the findings will be output by forms such as the Function chart, Mission Reliability chart, FMEA table and CA matrix.

At present, the enterprise uses only the FMEA table and CA matrix and only on the hardware FMECA. The enterprise lacks the suggestions to the potential designing change measures and doesn't analyze critical product further to get Inclemency Class I and Ⅱ Single Point Failure Mode List and Reliability of Critical and Major Product List. The authors think that the designing improvement suggestions and the two above lists should be carefully summarized as the focus of the output of the report, and also as the base of conducting the characteristic analysis. We should also pay attention to the division of the appointed level for the product, because the appointed levels division directly affects the analysis preciseness in Failure Effects column of FMEA table and the definition of Inclemency Class also will be affected. Those above have been defined in the standard Table 10, Classification Table in which the Failure Effects are classified by Appointed Levels.

2.2. Characteristic Analysis Report is the key point of the critical process identification

As a direct aspect of critical part (characteristic) and major part (characteristic) identification, Characteristic Analysis Report is detailed described in GJB 190-86 Classification of characteristics. However, just as the problem mentioned in 1.1, the designers don't adequately analyze the Technological Requirement in the standard and also lack the transmission approaches. At present, new technology, new materials, new equipments are broadly applied on the new researched critical and complicated products. The knowledge of the designers is deeper and deeper on product machining, assembly testing during program designing, sample preproduction, emulation and testing. Besides, the knowledge on Process Characteristics which directly affect the product function and its safety application has also been deepened continuously. However, this kind of knowledge is often used in meeting discussion and not written in technological documents and transmitted effectively. The authors think this part can be included in Technological Requirements of the Characteristic Analysis Report, and the outputs are the critical characteristics and major characteristics, which still are transmitted by Critical Part and Major Part Items List, but not to critical parts and major parts. The serial number of the subassembly drawings and general assembly drawings should be made clearly in the Remark column in the list, and the characteristic content should also be specified in the Technological Requirement column of the drawings and marked.

2.3. Technological Review is the inspection aspect for the critical process identification

Technological Document Review for Critical Parts, Major Parts and Critical Process (GJB 1269A-2000 Technological review 5.1.3) is an important part in Technological Review. Its 5.1.3.a and 5.1.3.b are the review requirements for integrity and consistency of critical process identification in technological documents. Therefore, to examine and inspect the work of the integrity and consistency between the content of critical process characteristics and characteristic identification of designing drawings and technological documents through technological review is the base to realize the closed loop control of the critical process. See Fig 1.

The designing drawing is the input of technological system. Critical Part and Major Part Items List, Accessories and Subassemblies List, the drawings of critical part and major part, subassembly drawings and general assembly drawings are all factors in critical process identification. It should be given enough emphasis to the examination on the integrity and consistency of the characteristic content and identification in accessories and subassemblies list, critical part and major part drawings, subassembly drawings and general assembly drawings and critical part (characteristic), major part (characteristic) in Critical Part and Major Part Items List to make sure the designing information transferred to technological system precisely.

Critical Working Procedure Content is the guiding document to the critical process control in technological document, and it is established upon the Critical Part and Major Part Items List with critical process about the machining process analysis. Therefore, we shall examine the consistency of characteristic content and characteristic identification between Critical Part and Major Part Items List and Critical Working Procedure Content first, and then examine the integrity of the Critical Working Procedure Content summarized by Technological Department in charge. Although there is no mark requirement for product technological general scheme and manufacturing working division, they are the distribution document for critical process control. Thus, they can be regarded as the content document for the critical process identification integrity examination of the technological document, upon which the updated critical working procedure content summary submitted by each manufacturing shop will be examined to make sure the precise transmission from technological department in charge to each manufacturing shop.

Critical part and major part can be divided into three categories: purchase, sub-contract and self-manufacturing. And the corresponding documents can also be divided into three categories. Purchasing equipment and materials for critical and major parts, as stated in 1.3 is a weak aspect in critical process control. Material Consumption Ration, Purchasing Document and Incoming Material Inspection Specification and Devices Reselection Specification are the key points for critical process quality surveillance in accordance with the requirements of GJB 5714-2006 Requirements for quality surveillance of purchased equipments and materials, 5.2. The consistency and integrity of characteristic content and characteristic identification shall be examined according to Critical Part and Major Part Items List. For critical subcontract process, the consistency of the related critical process requirements in subcontract agreement and the requirements in technological general scheme shall be reviewed.

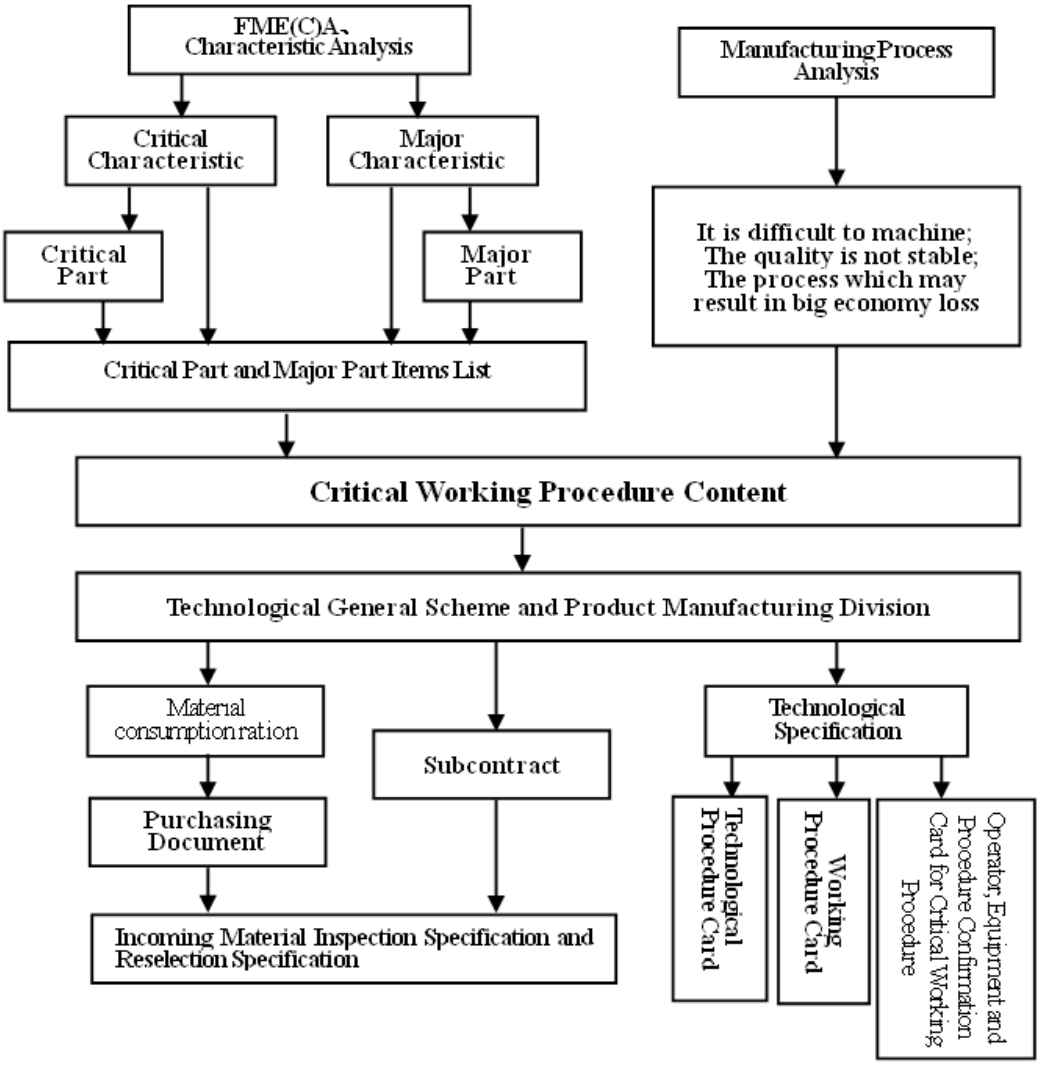

Fig. 1 .Critical Process Control Document Diagram

Technological Specification is the mandatory documentation in guiding manufacturing, inspection and testing. The consistency and integrity of the critical process characteristic content and characteristic identification of the technological specification should be reviewed in accordance with technological general scheme and manufacturing division, including the identification of technological procedure card, working procedure card and computer software used for production and service. As the terminal guidance document for critical process control, Operator, Equipment and Procedure Confirmation Card for Critical

Working Procedure should be reviewed for consistency of characteristic content in accordance with technological general scheme to assure the fully implementation of critical process control.

2.4. Readiness Review for the Preproduction is the full examination aspect for critical process control

GJB 1710A-2004 Readiness review for the preproduction and production, 5.1 specifies the content and requirements for readiness review for the preproduction from the following seven aspects: Designing Documentation, Preproduction Plan, facilities and environment, personnel, technological preparation, purchasing products and quality control. When we check and examine the result of readiness review for the preproduction to the implementation of critical process, we should not only review and examine the consistency and integrity of characteristic content and characteristic identification of technological document, designing documents and drawings, but also review and examine the consistency of facilities, special fixtures' types, the accuracy of inspection and measurement equipments, certificate of personnel and inspectors with the data having been specified in Operator, Equipment and Procedure Confirmation Card for Critical Working Procedure. Next, we should review if the storing environment for the critical and major parts and the protection characteristics of the carrying tools can meet the requirements. The implementation of critical process control shall be thoroughly and systematically examined from men, machines, materials, methods, environment and measurement through the examination of readiness review for the preproduction.

2.5. FAQ (First Article Qualification) is the final inspection aspect for the effect of critical process control

FAQ includes manufacturing process inspection and review, product inspection and review (GJB 908A-2008 First article qualification 5.2). But from the effect inspection of the critical process control, the focus is to inspect the consistency of the function characteristics and physical characteristics of the first article and its fittings. The consistency and integrity of the critical process identification in Part flow Card and General Assembly Card should be examined and reviewed in accordance with product designing drawings, and the consistency of measured data of the characteristic content will also be examined and reviewed. The effects of critical process control shall be thoroughly and fully evaluated through FAQ to assure if the critical process control capability can meet the requirements which have been continuously produced to meet the designing requests.

3. Critical Process Quality Surveillance Points during Product Manufacturing Period.

Based on the accurate identification and effective transmission of the critical process during the product developing period, the critical process control during the product manufacturing period shall be supervised from men, machines, materials, methods, environment and measurement according to the specific regulations of the Enterprise Procedures to make sure critical process is fully controlled. The authors suggest the enterprise also need to pay attention to the following 4 points.

3.1. Apply SPC (Statistical Process Control) to supervise critical process control

When SPC is applied in critical process control surveillance any time, the corrective actions will be adopted as soon as the abnormal waviness is found. Then the critical process will be in an acceptable and stable condition, and the stability of the product quality can be assured.

3.2. Apply dynamic management for critical process implementation

With the rapid development of technological system in enterprise, a number of new equipments and new fixtures have been applied, so the earlier confirmed critical processes may be not applicable any more. With the application of the product, on account of knowledge about the product having been deepened continuously, more and more quality problems caused by mismanagement of process control occur, which have been added for the control of critical process implementation. Therefore, the dynamic management should be applied for critical process implementation and close the problems at certain period to make sure the sufficiency and necessity of critical process control.

3.3. The engineering change related with critical process

The engineering change related with critical process shall be supervised from change application, analysis and demonstration, testing and verification and carrying out, in accordance with GJB 3206A Configuration management, 6.2.3 General Procedure for Configuration change seriously. The necessity and effectiveness for change shall be reviewed to make sure the consistency and integrity for carrying out the change.

3.4. The material substitution and concession application related with critical and major parts

For material substitution and concession application related with critical parts and major parts, the identification for substituted material and out-of-tolerance part should be marked in accordance with GJB 3206A 6.3.4 Deviation and Concession Control requirements. The distribution scope should also be controlled and recorded according to GJB 3206A 6.3.4 to make sure the traceability.

4. Conclusion

If any part in critical process is out of control, the entire critical process will be out of control and the final product and its safety application will be directly affected. Therefore, to conduct critical process quality surveillance should be started from the product development period with Five Performances Review, Technological Review, Readiness review for the preproduction and FAQ to identify critical process sufficiently with consistency and integrity. Besides, the implementation of the critical process control shall be verified. During product manufacturing period, closed-loop control of the critical process is performed from men, machines, materials, methods, environment and measurement. The application of SPC for critical process is supervised any time, Dynamic Management, Engineering Change Control, Material Substitution and Concession Application should be applied to make sure the critical process is fully controlled and the quality of the product is guaranteed.